Competency Based Modules for Semiconductor Manufacturing Education and Training

Michael Lesiecki, Ph.D.
Director

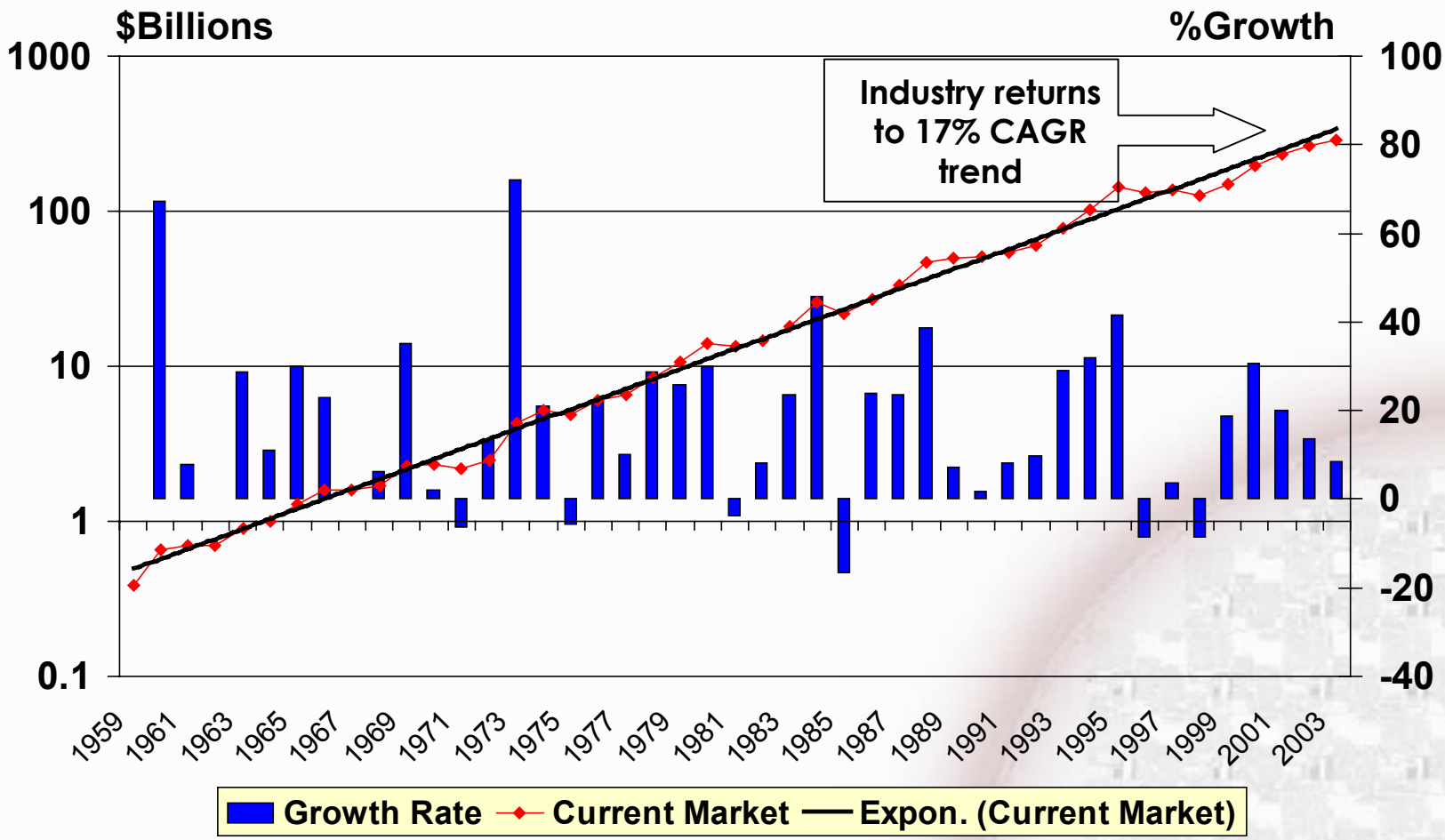
Maricopa Advanced Technology Education Center (MATEC)
A Division of the Maricopa Community Colleges
Tempe, Arizona, United States

http://matec.org
ERC Teleconference: April 12, 2001

MATEC

- Some slides that indicate industry trends and demand factors
- MATEC as an organization
- Curriculum Modules
  - Design and Delivery System
- Role of simulations and incorporation into modules
- Opportunities for collaboration/co-operation

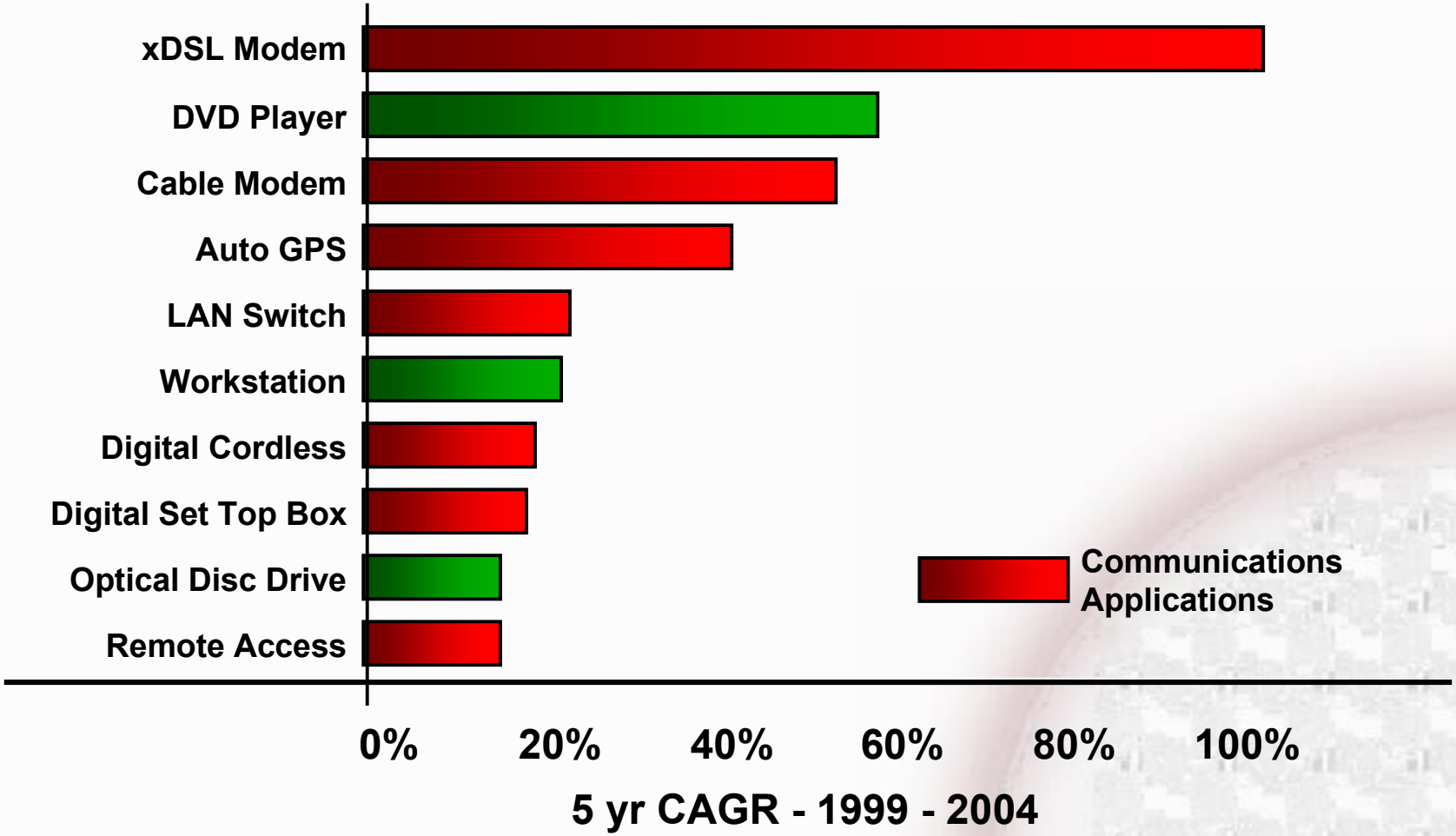
Semiconductor Industry Growth



Source: SIA June 2000 Forecast

MATEC

Top 10 Semiconductor Growth Applications



Source: Dataquest

MATEC

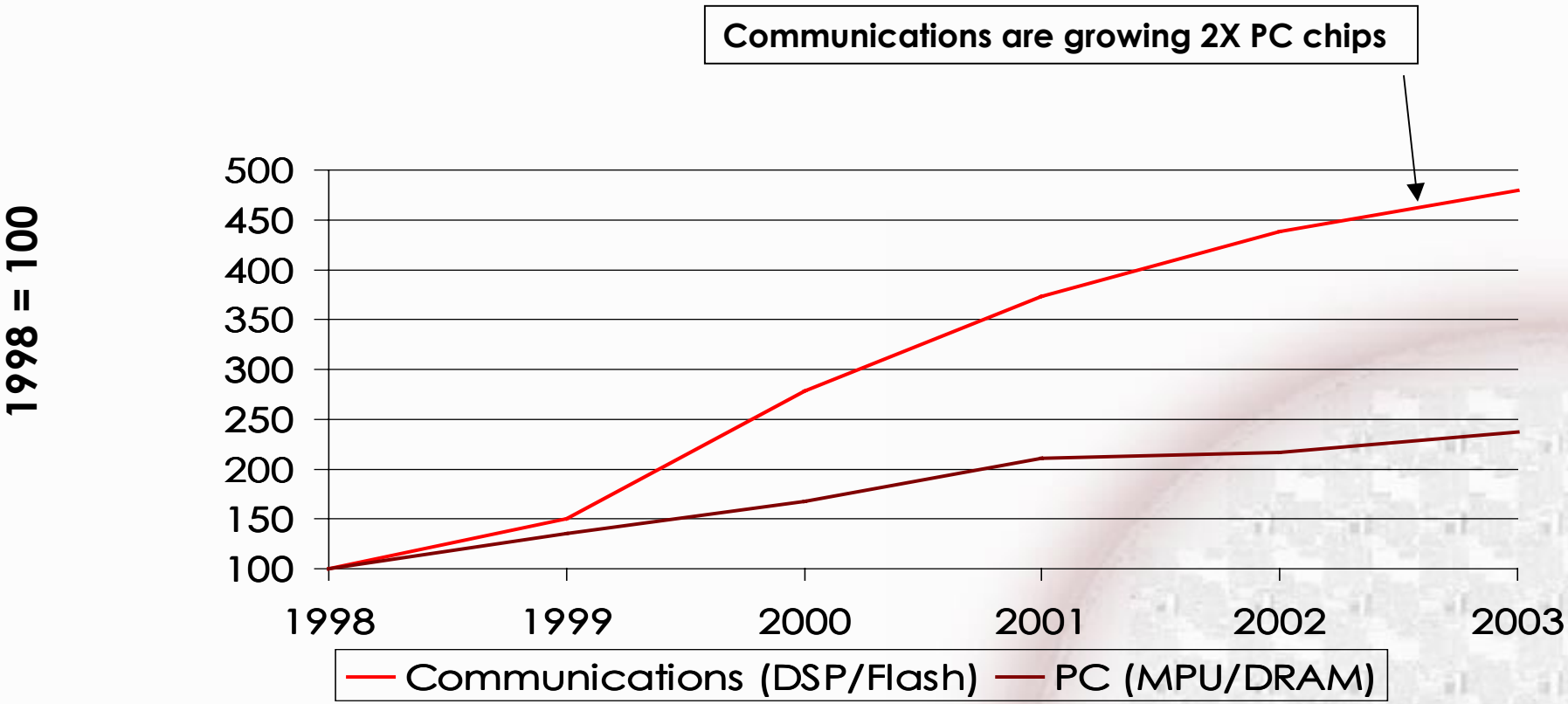
Semiconductor Content for Computers

Computer Type	S/C Content ($)
Mainframe	8 – 10%
Midrange Systems	10 – 14%
Workstations	15 – 18%
Personal Computer (PC)	30 – 35%
Personal Digital Assistant (PDA)	40 – 50%

Source: Integrated Circuit Engineering Corp.

MATEC

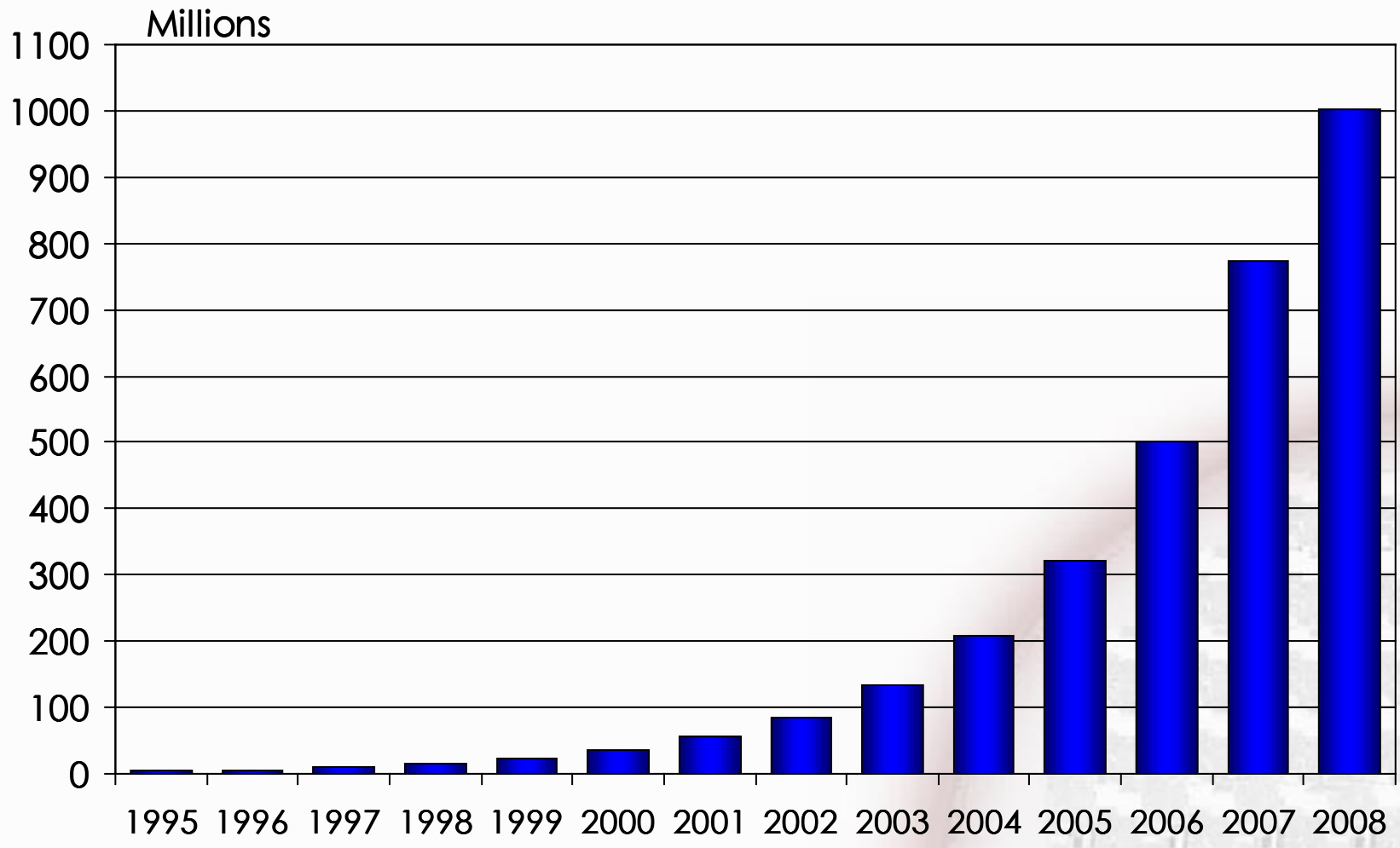
PC and Communication Chip Comparative Growth Rates



Source: SIA

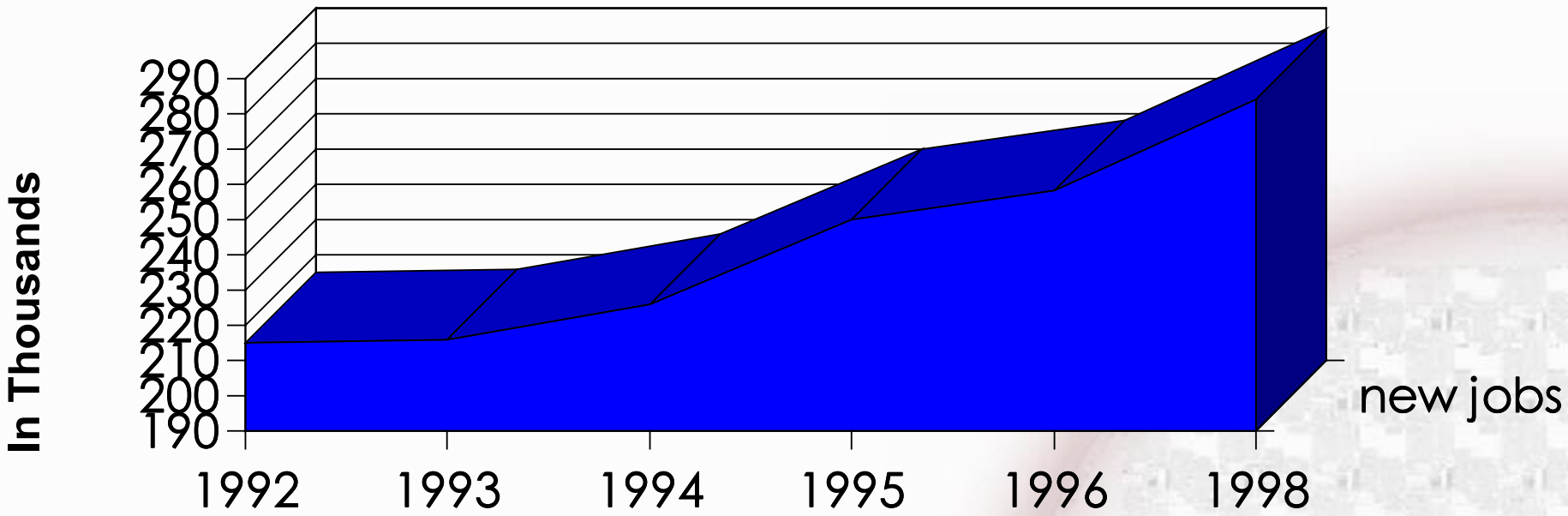
MATEC

Transistors Per Person



MATEC

And Growth Means….More New Jobs!



Since 1992, employment in the US.. semiconductor industry has increased by 69,000 jobs, or 32 percent.

Sources: US.. Bureau of Labor Statistics

MATEC

High Demand for Skilled Technicians

- Evolving Nature of Workplace
  - Work station owners
  - Technician of the future
- Role of Education and Training
  - Technical knowledge
  - Critical thinking and learning skills

The Problem

- Industry Growth and Technology Changes Create Need for:
  - More Workers
  - More, Skilled Workers
  - More, Differently Skilled Workers
- Projected Demand Exceeds Supply
- Technical Enrollments are Down in Some Cases

High-Technology Degrees Conferred 1990 vs 1996*

Degrees	1990	1996*	Percent Change
All Degrees	**1.9 million**	**2.1 million**	**+14%**
High Tech	**229,000**	**218,000**	**-5%**
Engineering	74,000	71,000	-3%
Engineering Technology	**58,000**	**49,000**	**-16%**
Computer Science	45,000	45,000	-1%
Business Info. Systems	**13,000**	**16,000**	**+24%**
Mathematics	21,000	19,000	-9%
Physics	7,000	7,000	-5%
Medical Technology	**6,000**	**7,000**	**+16%**
Communications Technology	4,000	3,700	-16%
Science Technology	**900**	**1,000**	**+12%**

*1996 data are the most recent available.

Source: U.S. Department of Education; AEA

MATEC

Educational Requirements for High Technology Occupations

- Science/Math Foundation
- Communication Core
- Technical Skills

MATEC

MATEC Was Created to Help Address This Issue

- Education/Industry Consortium led by Maricopa Community Colleges
- Collaboration for a Grant from the National Science Foundation
- Industries were able to establish a pre-competitive level of cooperation

MATEC as an Organization

MATEC

Maricopa Advanced Technology Education Center (MATEC)

- Center opened March, 1997
- A Permanent Center for Education and Work Force Development in the Semiconductor Industry
- With Significant Initial Funding from the National Science Foundation

Advanced Technological Education Centers

- **Seed Funding from the National Science Foundation**
- **Focus on Technician Preparation**
- **Systemic Improvement in Science, Math, Engineering and Technology**

MATEC

Member of a Network of Centers

- Currently 11 Nationwide
  - Information Technology
  - Telecommunications
  - Sustainable Resources
  - Marine Science
  - Environmental
  - Biotechnology
  - Advanced Manufacturing
  - ……
- www.nsf.gov/ate

MATEC

Center Activities

- Curriculum and Materials Development
- Faculty and Trainer Development
- Workforce Development
  - Awareness of opportunities
  - Increase number of skilled workers

Network of Partnerships

- **Currently 110 National and 12 International Partners**

MATEC

MATEC International Activities

- **International Partners**
  - IMT Akademie-Technik und Wirtschaft - Germany
  - Institute of Technical Education, Yishun - Singapore
  - Konig Wilhelm I – The Netherlands
  - Nanyang Polytechnic – Singapore
  - Ngee Ann Polytechnic – Singapore
  - North Tyneside College – United Kingdom
  - Northern Alberta Institute of Technology – Canada
  - SOFI – Universitaet Goettingen - Germany
  - Temasek Polytechnic – Singapore
  - Universidad Autónoma de Guadalajara – Mexico
  - Swinburne University of Technology, Victoria – Australia
  - Victoria University, Victoria – Australia

MATEC's Approach:

Provide Educational Resources for Faculty and Trainers

MATEC

Premise

- **High Technology Industries World-Wide Face The Need for a Skilled Workforce**
- **Educational institutions Can Answer This Need If ……**

MATEC

Learner Centered Education

- **Gives Learners Skills and Competencies**
- **Provides an Educational Foundation for Life Long Learning**

MATEC

The Learner Centered Model

- Motivation
- Knowledge Building
  - addresses different learning styles
- Practice
  - Hands-on
  - Simulations
- Assessment

Modules for Educators and Trainers

(Think of a Module as a 5-8 Hour Training Segment)

MATEC

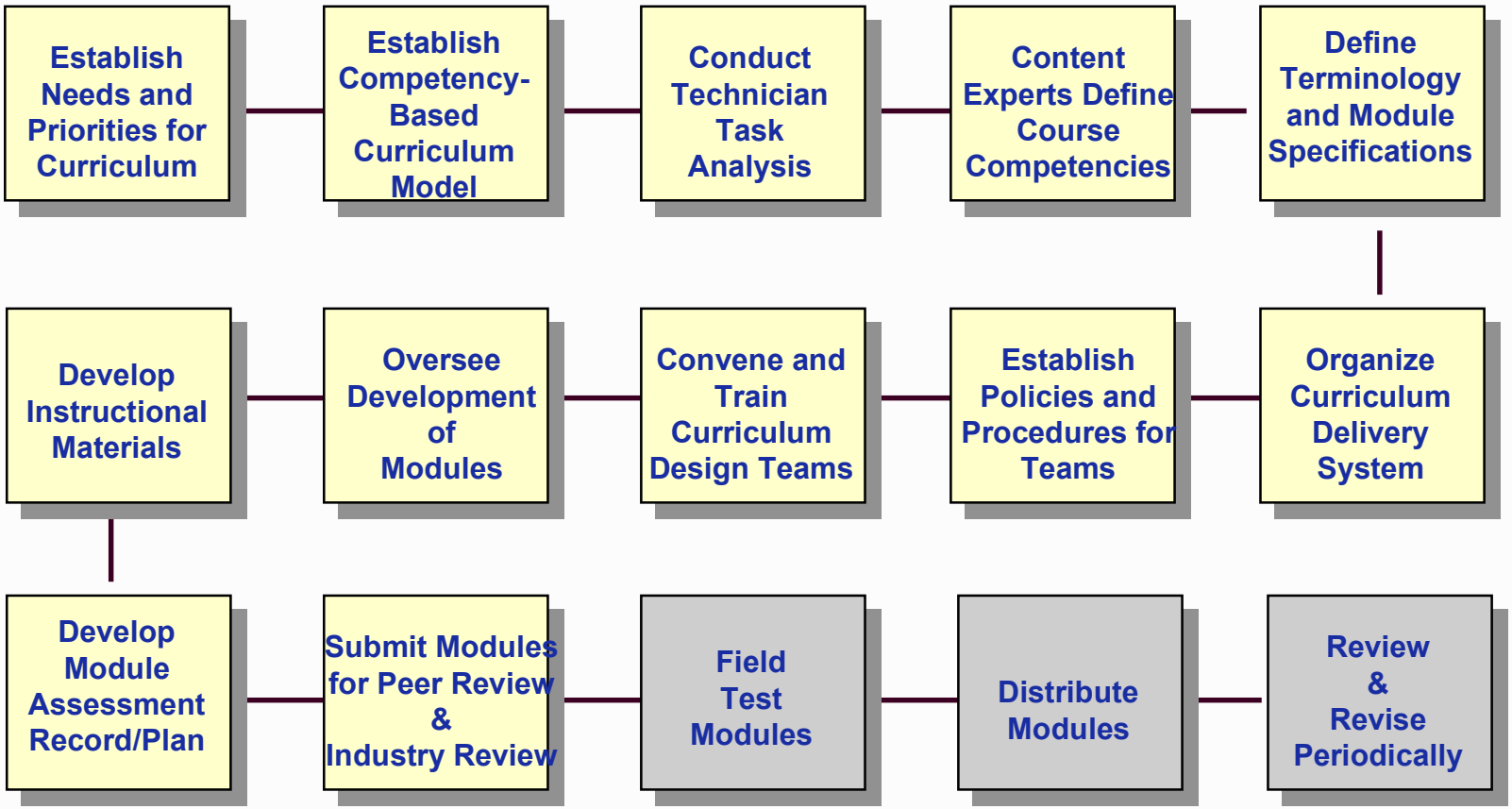
MATEC Curriculum and Materials Development

Provides curricula and materials that are responsive to industry needs and consistent with high academic standards:

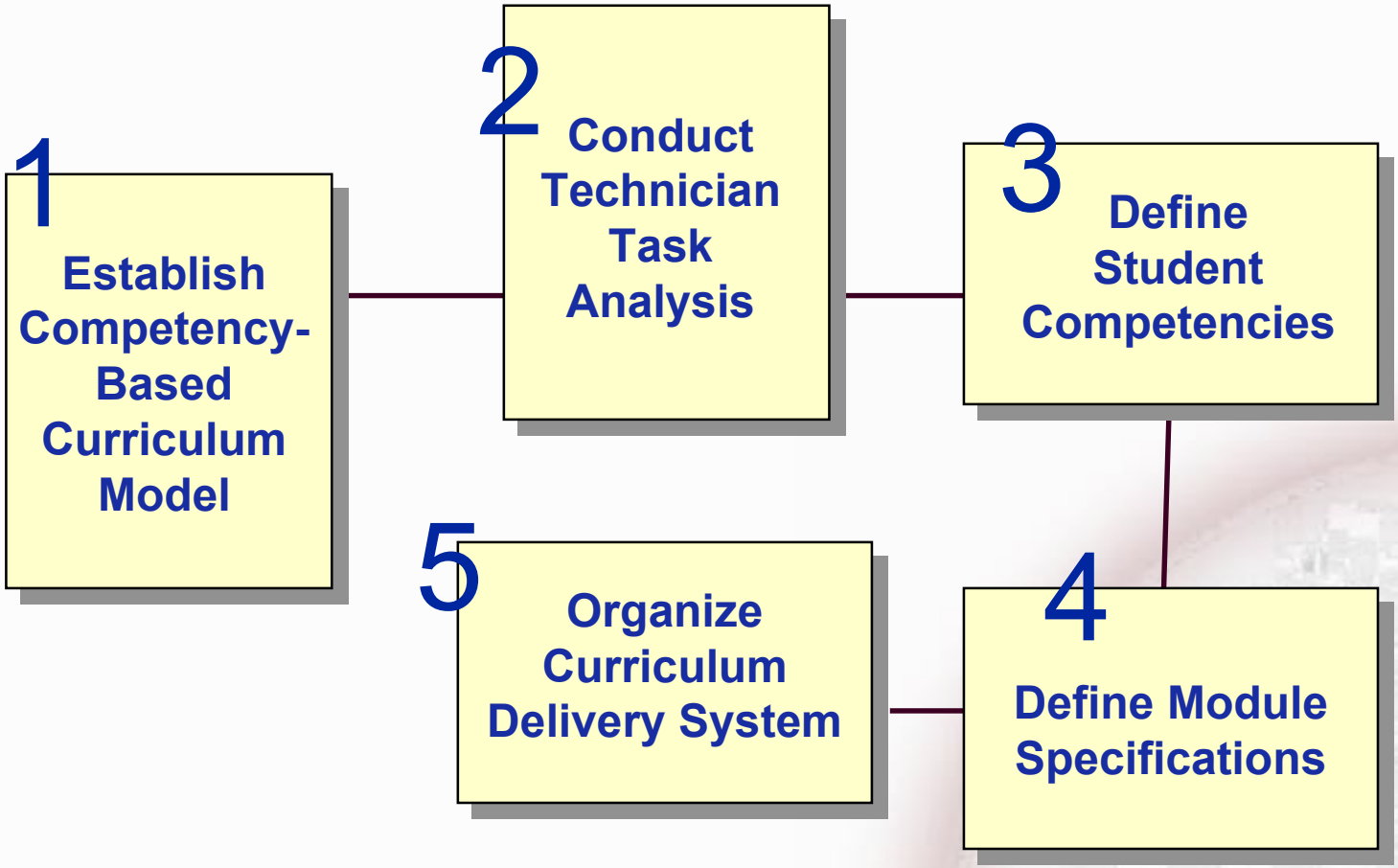
- **Complete**
- **Accurate**
- **Timely**
- **Relevant**

Uses state-of-the-art educational technologies to advance curriculum delivery

Curriculum Development Process



Curriculum Development Process (short form)



Competency:

A competency is a major skill, knowledge, attitude or ability needed to perform a task effectively and efficiently.

Modular Approach to Curriculum

- Adapted for Local Context
- Maximizes Return on Investment for Educators and Trainers
- Internet Delivered
- Unique Hybrid Web/CD-Rom System

MATEC

Interesting Screen Messages

The Web site you seek
cannot be located
but countless more exist

MATEC

Interesting Screen Messages

Chaos reigns within

reflect, repent and reboot

order shall return

MATEC EPSS Model

Electronic Performance Support System

- **Technical Advisor**
  - **Inform about the industry process/ products**
  - **Update on industry changes**

- **Teaching Associate**
  - **How to teach/manage a classroom setting**
  - **How to teach competency-based, learner-centered modules**

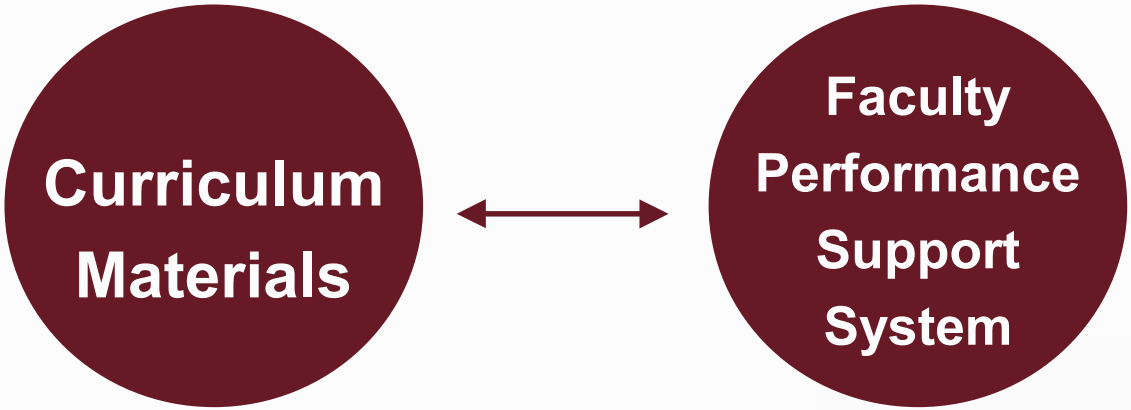
MATEC

MATEC Implementation: EPSS
Electronic Performance Support System

- Context Sensitive Learning Opportunities
- Delivered to the "Job Site" -- Instructor Office
- Learning on Demand
- Learning on an "As-Needed" Basis

MATEC

Curriculum Delivery System



- Module Narrative
- Learning Plan
- Lesson Plans
- Support Materials
- Media and Simulations
- Performance Assessment Task

- Teaching Assistant
- Technical Advisor

MATEC EPSS Model

Electronic Performance Support System

MATEC

Module Development (Process Set)

- ✓ Crystal Growth
- ✓ Diffusion
- ✓ Implant
- ✓ Lithography
- ✓ Oxidation
- ✓ Metallization
- ✓ Etch
- ✓ Deposition
- ✓ Planarization
- ✓ Assembly & Packaging
- ✓ Test & Sort

Unique Features of MATEC Modules

- Motivation
- Knowledge Building
- Practice
- Performance Assessment
  - Laboratory based
  - Simulation Based

MATEC

Unique Features of MATEC Modules (continued)

- Focus on Learning Activities
  - Addresses different learning styles
- Embeds work place skills
  - Teaming, communication, interpersonal, informal learning, training, self-assessment

Focus on Learning Activities

- Motivation
- Development of Job Aides
- Team work with self assessment
- Knowledge games
- Equipment research, study and simulations
- Informal and interactive lectures

MATEC

Role of Simulations

- Particularly Important for High technology Equipment Skills
- Basis for Performance Assessment
- “Pre-Staging” on CD Important for Bandwidth Issues

Collaboration

- Currently working with Gary Rubloff, U Maryland
- Incorporating subsets of EquipSIM
  - Vacuum, CVD
- Provides important transition from the learner's knowledge basis
- Sets up further work in the laboratory or a specific tool simulation
  - CBTs from SpeedFam-IPEC, AMAT

Strong Industry Interest and Move Toward Simulations

- Provides an opportunity for leveraged development
- Provides relevancy
- There is always a question of the level of the intended audience

Opportunities for Collaboration

- Creation of Unique Materials for Training and Education
- Input and Subject Matter Expertise
- Creation of Customized Modules/Media

MATEC

Advantages of Collaboration

- Key National Visibility With Industry Leaders in Industry and Education
- Workers Trained With Awareness and Knowledge of Technology
- Trained and Knowledgeable Workforce

Final Thoughts

- **If we don't succeed we run the risk of failure – Gov. GW Bush**

Summary - Instructional Materials for Trainers

- Currently 39 modules
- Reduce development time
- Increase instructional quality
- Opportunities for customized delivery and development of student materials

MATEC

Summary

- **MATEC was created as a permanent center to address the needs of a highly skilled workforce.**
- **A unique System for the delivery of instructional materials for educators and trainers has been created.**
- **This system can work in collaboration with genuine hands-on learning to provide the knowledge, skills and abilities that are needed.**

Acknowledgements

Cathleen Barton and Daryl Hatano of the Semiconductor Industry Association for use of their data and slides

MATEC

Our Web Site

http://matec.org

MATEC

“Before I came here I was confused about this subject. Having listened to your lecture I am still confused. But on a higher level.” - Enrico Fermi